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ONTARIO
Department of Education

Courses of Study

Grade XIII

PHYSICS

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PHYSICS, GRADE XIII

Introduction

The purposes in view are as follows:

1. To present a course with sufficient balance between experiment and theory to hold the interest of the average pupil.
2. To make a survey, with sound mathematical background, of the general field of physics, so as to meet the needs of the pupil whose academic career ends at this stage.
3. To give to the pupil an introduction to some of the newer applications of physics.
4. To bridge the gap between the secondary school and the university in such a way that there will be as little time lost as possible in adjusting the first-year pupil to university methods.

(a) Mechanics

Motion. (Three periods.) A review of velocity and Newton's First Law of Motion. Uniform velocity.

(Twelve periods.) A quantitative study of uniformly accelerated motion with illustrative experiments, e.g. with Galileo board or Fletcher trolley. Graphical representation of uniform motion and of uniformly accelerated motion. Meaning of velocity at a point.

Experimental determination of acceleration due to gravity. Problems.

(Fifteen periods.) Newton's Second Law of Motion. Experimental illustration. Momentum and impulse. Inertia. Distinction between weight and mass.

Relation between gravitational and absolute units of force; gram and dyne; pound and poundal. Problems.

(Nine periods.) Newton's Third Law of Motion. Meaning of stress. Law of Conservation of Momentum. Applications and problems.

Centripetal and centrifugal forces. Applications.

A discussion of the Law of Universal Gravitation with brief reference to any illustrative experiments.

Energy. (Eighteen periods.) A review of work, energy, and power, with applications and problems.

Definition of units: erg, joule, gram-centimetre, foot-poundal, foot-pound, watt, horse-power, kilowatt-hour, watt-second.

Gravitational potential energy; definition and derivation of formula (mgh).

Kinetic energy; definition and derivation of formula ($\frac{1}{2}mv^2$).

Discussion of Joule's determination of mechanical equivalent of heat. Meaning of the efficiency of a machine.

Friction. (Eight periods.) Experiments to illustrate static, limiting static, and kinetic friction.

Experimental determination of the coefficients of static and kinetic friction.

Laws of friction (problems not required).

The role of friction in the operation of machines.

Reduction of efficiency of machines by friction.

(b) Electricity

Electrostatics. (Two periods.) A review and extension of electrostatics of Grade XII.

An experiment to show that both positive and negative charges are induced on an uncharged insulated conductor when a charged body is brought near it (Canton's experiment).

(Two periods.) Demonstration and discussion of the charging of an insulated conductor by induction. Explanation in terms of electrons.

(One period.) An experiment to show that a charge placed on an insulated hollow conductor goes to the outer surface, e.g. Faraday's ice-pail experiment.

A brief discussion of shielding with practical application, e.g. in a radio tube.

(Two periods.) An experiment to show the escape of a charge from a point, e.g. Franklin's experiment. The lightning rod.

(Three periods.) Meaning of potential difference.

Review the meaning of work, energy, and power, with emphasis on gravitational potential energy.

A demonstration with a positively charged pith ball (at the end of a short silk thread tied to a glass rod) between two charged insulated plates, one positive, the other negative, to show (1) the existence of a force acting on the pith ball anywhere in the region between the plates, (2) that the pith ball, if free to move, will go from the positive to the negative plate, and (3) that work must be done on the pith ball to move it from the negative to the positive plate.

Explanation of the meaning of potential difference as a difference in potential energy and of the movement of charges, if free to move, whenever a potential difference exists. Reference to the volt as a practical unit of potential difference.

Measure of the magnitude of potential difference by the length of the spark obtained from an electrophorus or induction coil or other apparatus.

Capacity. (Seven periods.) An experiment with an electroscope and attached insulated plate (condensing electroscope) to show the variation of capacity with (1) area of plate, (2) distance between the charged plate and a grounded plate, and (3) the nature of the dielectric. Structure and use of condensers of different forms. Derivation of $Q = CV$, where Q is the quantity of electricity, C the capacity, and V the potential. The farad and micro-farad. Simple problems. An experiment with condensing electroscope to show the presence and the nature of the charge on each terminal of a voltaic cell.

Electrical energy.
(Eight periods.)

Measurement of electrical energy and electrical power. Proof that the energy gained when Q coulombs move in a wire under a potential difference of V volts is VQ joules, and that the electric power is VI watts, I being the number of amperes and the volt defined as such a potential difference that the work done per coulomb is one joule.

The meaning of kilowatt-hour as a unit of energy. Calculation of the cost of energy in using electrical appliances.

Electrical method of measuring the mechanical equivalent of heat. Simple problems.

Thermionic emission.
(Three periods.)

An experiment with a diode tube (any radio tube may be used) to show that a current passes through the tube if (1) the filament is hot, and (2) the filament is negative with respect to the opposite electrode.

Simple discussion of the liberation of electrons from a hot metal.

Experiment using A.C., to show the use of a radio tube in allowing current to flow in one direction only.

The meaning of rectifier and rectification.

Photoelectricity.
(Two periods.)

An experiment to show that when light from an arc falls on a clean zinc plate connected to a negatively charged electroscope the electroscope loses its charge. The meaning of photoelectricity; the structure and uses of a simple photoelectric cell and of a phototronic cell.

(c) Energy Transmitted by Waves

Sound.
(Five periods.)

Experiment with a cord under tension to show standing waves. Discussion of this experiment and the principle of superposition by means of graphs representing two trains of waves travelling with equal velocity along the same line but in opposite directions. Nodes and loops. An experiment to show standing sound waves in an air column and to measure the wave-length and the velocity of sound in air. An experiment to determine the frequency of a tuning fork, preferably by some form of vibrograph.

(Four periods.)

Discussion of the meaning of resonance as illustrated by experiments (1) with tuning fork and air column, and (2) with tuning forks or resonance bars of the same frequency. Sympathetic vibrations. A mechanical illustration of the principle of resonance.

(Four periods.)

Experiments to illustrate the interference of sound waves due to superposition: (1) silent points near a sounding tuning fork; (2) Herschel's divided tube; (3) the production of beats. Discussion of the use of interference in Herschel's divided tube to measure the wave-length of sound.

Light.
(Five periods.)

The following simple experiments to show that the transmission of light has the characteristics of a wave disturbance:

(a) An experiment to show the spreading out of light when a single straight incandescent filament is viewed through a narrow aperture, e.g. a narrow crack between two fingers held before the eye.

(b) An experiment to show interference of light when the single filament is viewed through two narrow openings.

(c) An experiment to show interference with light reflected from a thin soap-film.

(Three periods.) An experiment with sodium flame and air wedge between two glass strips to measure the wave-length of sodium yellow light.

An experiment with pins and a glass block to measure the index of refraction from air to glass. Proof that $\sin i/\sin r = v_1/v_2$, where v_1=velocity in first medium and v in the second.

(Seven periods.) An experiment to show deviation through a prism. Experiments to demonstrate the spectrum of white light and the combination of spectrum colours to form white light. A discussion of the range of wave-lengths in the visible spectrum. An examination, by looking through a diffraction grating, of the flame spectrum of a few common elements such as sodium, calcium, and lithium, and of the vacuum-tube spectra of such gases as neon, nitrogen, and hydrogen (an inexpensive diffraction grating will serve).

A brief discussion of spectrum analysis and the uses of the spectroscope and the spectrograph. A brief discussion of the infra-red, and of the ultra-violet portions of the spectra.

Polarization. (Two periods.) Experiment with two pieces of polaroid to show the nature of plane polarized light. Discussion of the use of polaroid in overcoming glare due to approaching car headlights.

(Two periods.) Experiment with a piece of polaroid to show polarization by reflection from non-metallic smooth surfaces. Discussion of the use of polaroid in overcoming glare due to reflected light.

Radiant energy. (Five periods.) A discussion, with experiments where possible, of means of detecting radiant energy, such as (a) the blackened bulb of a thermometer, (b) Crookes radiometer, (c) a thermocouple, (d) photoelectric or photronic cell, and (e) photographic plate.

Experiments to show (i) the difference in the absorption of radiant energy by a dark and by a polished surface, and (ii) the difference in the emission of radiant energy by such surfaces. Discussion of (i) the reason for silvering a thermos flask and polishing a calorimeter, and (ii) the reasons for the rise of temperature in a hot-house.

Law of inverse squares. (Five periods.) Geometrical derivation of the Law of Inverse Squares for any kind of radiation from a small source, when there is no absorption.

Experimental verification by the use of a photometer with two light sources of known candlepower, or by use of a photoelectric cell with a single source of unknown candle-power, or by a hot ball and thermocouple.

Experiment to compare the candle-power of luminous sources by any type of photometer.

Brief reference to foot-candle metre and exposure metre.

X-rays.
(Two periods.)

An experiment with a small X-ray tube and an induction coil to show (1) the discharge of an electroscope by X-rays, and (2) the passage of X-rays through such substances as wood and paper.

Brief reference to the origin of X-rays and to the magnitude of their wave-lengths.

Electric waves.

Brief reference (illustrated if possible by one or more experiments, such as Lodge's resonance experiment) to oscillatory electric circuits and the generation of electric waves.

A discussion of the range of wave-lengths of electric waves, including radio waves. The meaning of kilocycles per second, and the relation of frequency in kilocycles per second to the wave-length in metres.

(d) Applied Optics

Lenses.
(Two periods.)

Review of the formation of images by a converging lens.

Similar experimental study of the diverging lens.

(Six periods.)

Derivation of lens formula:

$$\frac{1}{\text{object distance}} + \frac{1}{\text{image distance}} = \frac{1}{\text{focal length}}.$$

Simple problems based on this formula.

The linear magnification produced by a lens.

Experimental determination of focal length of a converging lens and of linear magnification by measurement of object and image distances.

Magnifying power.
(Three periods.)

Review of vision by unaided eye and of power of accommodation. Distance of most distinct vision without undue eye strain. Use of a converging lens as a magnifier. Discussion of most favourable position of image (at infinity) to avoid eye fatigue. Definition of magnifying power as ratio of size of image on the retina when object is viewed through magnifier to its size when viewed directly at optimum distance.

(Three periods.)

Experiment with two lenses to illustrate the principle of the astronomical telescope. Diagram of ray paths.

Proof that the magnifying power of the telescope (the ratio of the angle subtended at the eye by the image to the angle subtended by the object when viewed directly) is equal to the ratio of the focal length of the objective to that of the eye-piece.

(One period.)

Experiment with two lenses to illustrate the principle of the compound microscope. Diagram of ray paths.